EXACT

COMPANY INC.

PRELIMINARY

MANUAL

TYPE 200 WAVEFORM SYNTHESIZER

AND

ASSOCIATED PLUG - IN GENERATORS

MASTER COPY
MAINTENANCE AND CALIBRATION FILE
NOT TO BE REMOVED FROM IMMEDIATE AREA

O P E R A T I N G P R O C E D U R E

I. FRONT PANEL FAMILIARITY

A. PRIMARY MATRIX (50 Black Knobs)

These potentiometers control the suppressor bias on the PRIMARY MATRIX readout tubes and provide 50 independantly variable (over a 50 volt range) increment levels to the plug-in. Order of continuous adjustment is front left to right in descending order.

B. SECONDARY MATRIX (50 Red Knobs)

These potentiometers control the suppressor bias on the SECONDARY MATRIX readout tubes and provide 50 independantly variable (over a 50 volt range) increment levels to the plug-in. Order of continuous adjustment is from left to right in descending order.

C. NEON INDICATORS

Neon bulbs located in the plate circuits of the Vertical and Horizontal counter switching tubes. The operating vertical row (5 neons) is indicated by the bulb which is ON. The operating vertical row (5 neons) is indicated by the bulb which is ON. The operating horizontal row (10 neons) is indicated by the bulb which is OFF. Intersection of the rows indicates the single increment in use.

D. B, C, D, E ON-OFF SWITCHES

DPDT slide switches are located in the plate circuits of four of the five Vertical Counter trigger tubes. The Vertical Counter skips whichever row or rows are turned to OFF. This provides a minimum of 10 increments (A cannot be turned off) and any combination of 10 up to 50.

II. TYPICAL OPERATION

Since the basic unit relies on the plug-in not only for trigger timing, but also for the forming of the output waveform, a more complete description of operating techniques will be found under OPERATING PROCEDURE in the PLUG-IN SECTION.

A. If less than 50 increments are desired, multiples of ten can be switched out by use of the A, B, C, or D ON-OFF SWITCHES.

Rows can be programmed and switched off to be used when desired with Row A.

II. TYPICAL OPERATION (continued)

CAUTION: Since these are ring counters, the unit may lock out on a single row if that switch is moved to OFF while that row is counting.

This will be more apt to happen at the faster speeds. If it does, either turn the switch ON and OFF again, or go to a slow speed where the neon indication can be observed and turn the switch to OFF while another row is energized.

B. The precise instantaneous output increment can be determined by the intersection of the neon indicators. For example: if the third neon from the left is OUT and the fourth neon from the top is ON, the output is from the 33rd increment.

C I R C U I T D E S C R I P T I O N

I. POWER SUPPLY

A. TRANSFORMER

Filament and all DC voltages are supplied by a single transformer T101 which operates between 105-125 volts (210-250 volts in export models). There are three hi-voltage secondaries and five 6.3 volt filament windings.

B. RECTIFIERS

Hi-voltage AC is rectified by silicon diode rectifiers connected in a full wave bridge.

C. -210V REGULATED SUPPLY

All DC voltages in the type 200 must have a stable reference voltage in order to properly regulate against load and input variations. V104, a gas diode, is this stabilized reference and sets the grid voltage on V103A. The -210V ADJ. is made to balance the supply for a -210 volt output. Any change in voltage appearing at the grid of V103B (including line voltage changes) will be compared to the reference voltage on the grid of V103A. Any difference will be great amplified by V102 causing V101 to be biased in the direction to correct for the change.

D. +100 VOLT SUPPLY

This supply operates in essentially the same manner as the -210 volt supply. The -210 volt supply becomes the reference and any variation of the grid of V106 is amplified and fed to V1076 for correction.

E. +250 VOLT SUPPLY

This supply operates in the same manner as the -210 volt and +100 volt supplies. The -210 volt supply is the reference and any variation at the grid of V108 is amplified and fed to V107a for correction.

F. -60 VOLT SUPPLY

This voltage is derived by dropping the -210 volt supply by 150 volts through the gas diode V313.

G. All power supply voltages are fed to the circuits of the SYNTHESIZER as well as to the interconnecting plug delivery volt power to the plug-in being used.

II. HORIZONTAL COUNTER

A. TRIGGER TUBES V205, V215, V220, V225, V230, V235, V240, V245 and V250

The trigger tubes are connected in a manner that allows the common trigger pulse on the cathodes (pins 7) to trigger the HORIZONTAL multivibrators (V204, etc.) in sequence only. (Only one HORIZONTAL multivibrator is in the "ON" position at any one time).

When V204, for example, is in the "ON" position, the grid (pin 2), being connected to the grid (pin 1) of V205, has a high enough potential to arm this trigger tube for the next stage.

When the next trigger pulse drives the common trigger cathodes (pins 7) negative, it will cause V205 to conduct and trigger V209, turning it "ON".

V250 furnishes trigger from screen to T201 which developes sharp spike to V317B. It is amplified and fed to VERTICAL COUNTER trigger tubes at the proper time.

B. SWITCHING TUBES V204, V209, V214, V219, V224, V229, V234, V239, V244 and V249

These are bi-stable multivibrator in a ring counter configuration. They are sequentially gated by the trigger tubes. Because of the common cathode connections, only one multivibrator can be "ON" at any one time. The stage is considered "ON" when the left tube is not conducting and the right tube is.

III. VERTICAL COUNTER

A. TRIGGER TUBES V303, V306, V309, V312 and V316

The trigger tubes are connected in a manner that allows the common trigger pulses on the cathodes (pins 7) to trigger the VERTICAL multivibrators (V302 etc.) in sequence only. (Only one VERTICAL multivibrator is in the "ON" position on any one time).

When V302, for example, is in the "ON" position, the grid (pin 2), being connected to the grid (pin 5) or V303, has a high neough potential to arm this trigger tube for the next stage.

When the next trigger pulse drives the common trigger cathodes (pins 7) negative, it will cause V303 to conduct and trigger V304, turning it "ON".

B. SWITCHING TUBES V302, V305, V308, V311, and V315

These are bi-stable multivibrator in a ring counter configuration. They are sequentially gated by the trigger tubes. Because of the common cathode connections, only one multivibrator can be "ON" at any one time. The stage is considered "ON" when the left tube is not conducting and the right tube is.

C. CATHODE FOLLOWERS V301, V304, V307, V310 and V314

These tubes are connected in parallel with their cathodes tied to a row of ten PRIMARY and ten SECONDARY MATRIX potentiometers. At any given time only one cathode follower is turned on by a switching tube. The other four are cut off thereby removing the remaining potentiometers out of operation. The one cathode follower conducting furnishes a current path for the corresponding row of PRIMARY and SECONDARY MATRIX controls.

IV. PRIMARY and SECONDARY MATRIX

These circuits, although separate in output, are identical in operation and circuit description. So only the PRIMARY MATRIX will be described. All features will apply identically to the SECONDARY MATRIX.

A. MATRIX CONTROLS

The 50 diodes and potentiometers in each matrix are identical in operation. The potentiometer, when a current path is furnished by a VERTICAL COUNTER cathode follower, adjusts the voltage to the suppressor grid of a readout tube through a matrix cathode follower. The diode properly isolates the voltage on each control from any of the other 4 on the common buss (Remember even though 5 vertical diodes are tied together, only one horizontal row is turned on at a time).

B. MATRIX CATHODE FOLLOWERS V201, V206, V211, V216, V221, V226, V231, V236, V241, V246

Provide isolation between readout tubes and matrix components.

C. MATRIX READOUT TUBES V202, V207, V212, V217, V222, V227, V232, V237, V242 and V247

Pentode amplifiers which provide selective amplification of matrix outputs (suppressor input). These tubes are switched on one at a time (control grid input), thus producing an output of only one increment at a time.

The suppressor grid voltages are determined by the individual settings of the matrix potentiometers in the "switched on" row.

Each control grid is connected to a corresponding HORIZONTAL COUNTER switching tube. Coincidence and corresponding readout of the suppressor voltage setting is obtained as each readout tube is sequentially "turned on".

V105 and associated circuitry provides the necessary total waveform compensation and low impedance output to the plug-in.

CALIBRATION PROCEDURE

The following is a factory calibration procedure and should rarely, if ever, need to be completely duplicated once the instrument is in operation. It is furnished for your assistance in recalibrating certain sections after you have made a major repair, or in checking operating during preventive maintenance.

I. POWER OFF (plug-in NOT installed)

A. VISIBLE WIRING CHECK

B. PRESET all trimmers and potentiometers to mid-position.

C. POWER SUPPLY RESISTANCES (20,000Ω/volt meter)

1. -210V reg. (3.5K)
2. +100V reg. (3.5K)
3. +250V reg. (20K)
4. +100V unreg. (5K)
5. +250V unreg. (15K)

II. POWER ON (install a plug-in generator)

A. TURN POWER ON

B. POWER SUPPLY VOLTAGES

1. Adjust -210V ADJ (on top left hand side of power supply chassis).

   Check potentiometer for sufficient range

2. Check +100V (±5%)

3. Check +250V (±5%)

C. CHECK COUNTERS FOR OPERATION

1. Switch TIME/INCREMENT switch in plug-in to slow range

2. Observe neon indicators for proper sequential counting (be sure all row switches are turned ON).

NOTE: IN ALL CHECKS REQUIRING AN OSCILLOSCOPE USE AN INSTRUMENT HAVING REGULATED POWER SUPPLIES AND DEPENDABLE ACCURACY

D. POWER SUPPLY RIPPLE (check with oscilloscope)

1. -210V (10-15 millivolts)
2. +100V (10-15 millivolts)
3. +250V (10-15 millivolts)

E. POWER SUPPLY REGULATION (using a Variac, vary the input voltage from 95 to 130 volts; the SYNTHESIZER should stay in regulation between 105-125 volts)

1. -210V
2. +100V
3. +250V

F. CHECK PEAK-CURRENT LIMITING RESISTANCE (10Ω resistors in power supply) VOLTAGE DROP

1. -210V (2 volts)
2. 100V (1.2 volts)
3. +250V (0.4 volts)

G. HORIZONTAL TRIGGER ADJ. (located in plug-in)

1. Run plug-in at 100μSEC. TIME INCREMENT

2. Monitor SCALE OF TEN out with oscilloscope and set oscilloscope gain high enough to see small spikes on base line along with large pulse.

3. Pull VERTICAL trigger tube V317 to eliminate any interaction from vertical trigger.

4. Turn HORIZ. TRIG. ADJ. through range and observe the change of time between large pulses.

5. By counting the spikes between pulses, set HORIZ. TRIG. ADJ. at optimum position on a count of 10.

H. VERTICAL TRIGGER ADJ. (Located below V249 on right hand underneath side of main chassis)

1. Replace VERTICAL trigger tube V317.

2. With oscilloscope monitoring the same as in Step "G" Adjust VERT. TRIG. ADJ. to point of oscillation and then back off several degrees.

3. Slightly readjust HORIZ. TRIG. ADJ. in plug-in for maximum stability.

4. Check VERTICAL trigger pulse at pin #9 V317. Should be approximately 3 volts with no negative going portion.

I. CHECK ALL COUNTING AND TIMING

1. Observe counters for operation throughout range of plug-in TIME/INCREMENT.

CALIBRATION PROCEDURE (continued)

I. CHECK ALL COUNTING AND TIMING (continued)

2. Turn off row switches one by one and observe proper lockout. This should be done at slow TIME/INCREMENT speeds to avoid locking out on the row being turned OFF.

J. READOUT LEVEL - PRIMARY and SECONDARY

1. With an oscilloscope, monitor the junction of HORIZONTAL COUNTER plate dividers R2001 and R2021. The top of the pulse is at ground.

2. Adjust READOUT LEVEL ADJ., R2000 for approximately -20 volts

3. Check remaining plate divider junctions for -20 volts (±10%)

K. PRIMARY MATRIX COMPENSATION

1. Monitor pin #3 of V105 and observe the first 10 increments

2. Set each of the first 10 increments alternately positive and negative so that a square wave pattern is observed.

3. Adjust primary MATRIX COMP., C201 for squarest waveform.

L. SECONDARY MATRIX COMPENSATION

1. Monitor pin #8 of V105 and observe the first 10 increments

2. Set each of the first 10 increments alternately positive and negative so that a square wave pattern is observed.

3. Adjust secondary MATRIX COMP., C201S for squarest waveform.

M. PRIMARY READOUT COMPENSATION

1. Monitor pin #3 of V105 and observe first 10 increments.

2. Set first 10 increment levels to approximately mid-position.

3. Adjust primary READOUT COMP. trimmers C2001 thru C2010 (located in the plate circuits of the HORIZONTAL COUNTER switching tubes) for minimum spike. (330μsec/INC Pos.)

N. SECONDARY READOUT COMPENSATION

Monitor pin #8 of V105 and proceed as in Step M above adjusting secondary READOUT COMP trimmers C2011 - C2020.

CALIBRATION PROCEDURE (continued)

O. PRIMARY HIGH FREQUENCY ADJ.

1. Set plug-in TIME/INCREMENT to 10μsec.

2. Set all of first 10 increment levels to "0" except one, which is set to maximum positive amplitude.

3. Set test oscilloscope sweep speed to observe leading edge of pulse at pin #3 V105.

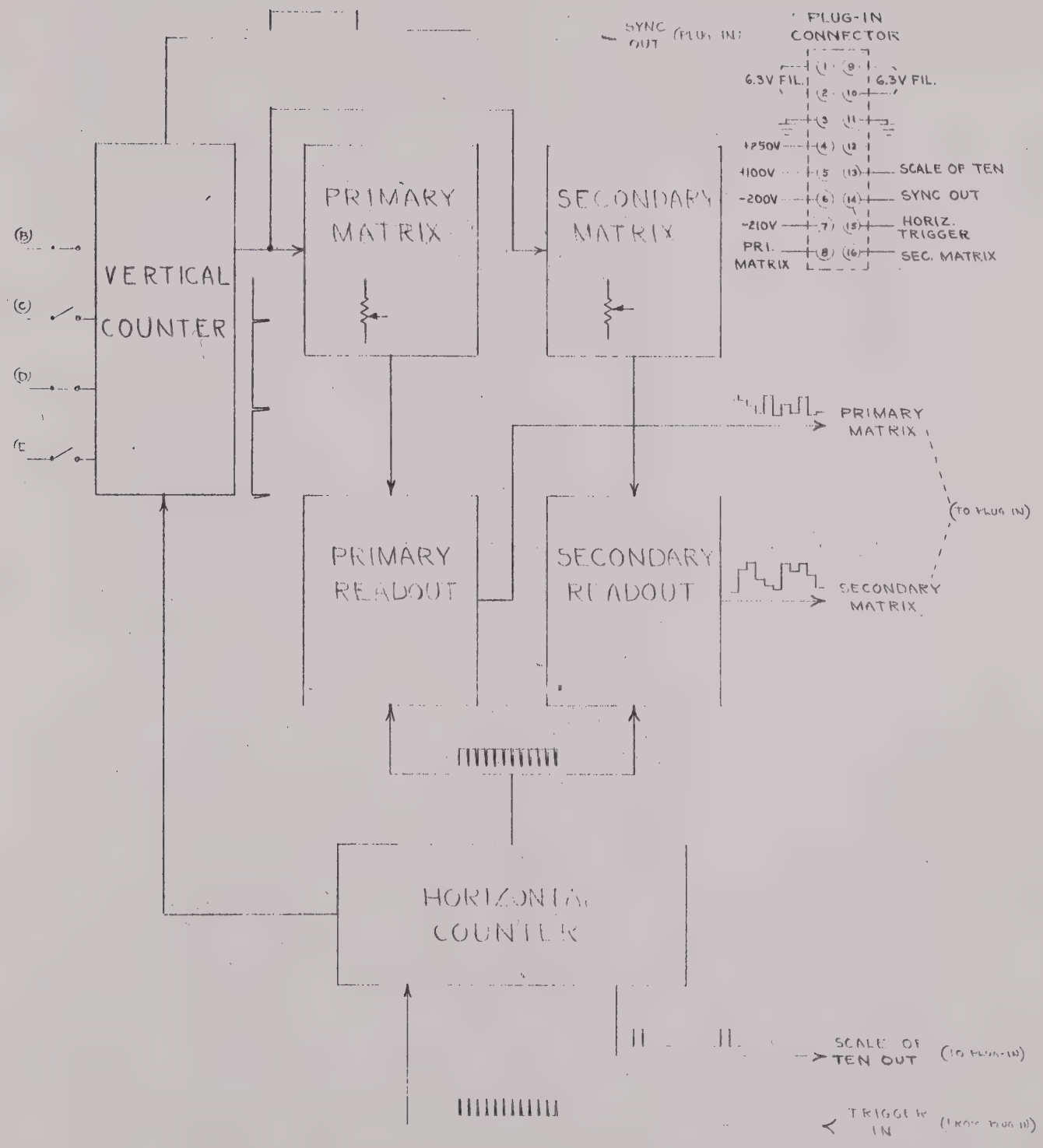
4. Adjust primary H.F. ADJ. L201 for sharpest wave front.

P. SECONDARY HIGH FREQUENCY ADJ.

Monitor pin #8 V105 and proceed as in Step "O" above, adjusting secondary H.F. ADJ. L201s for sharpest wave front.

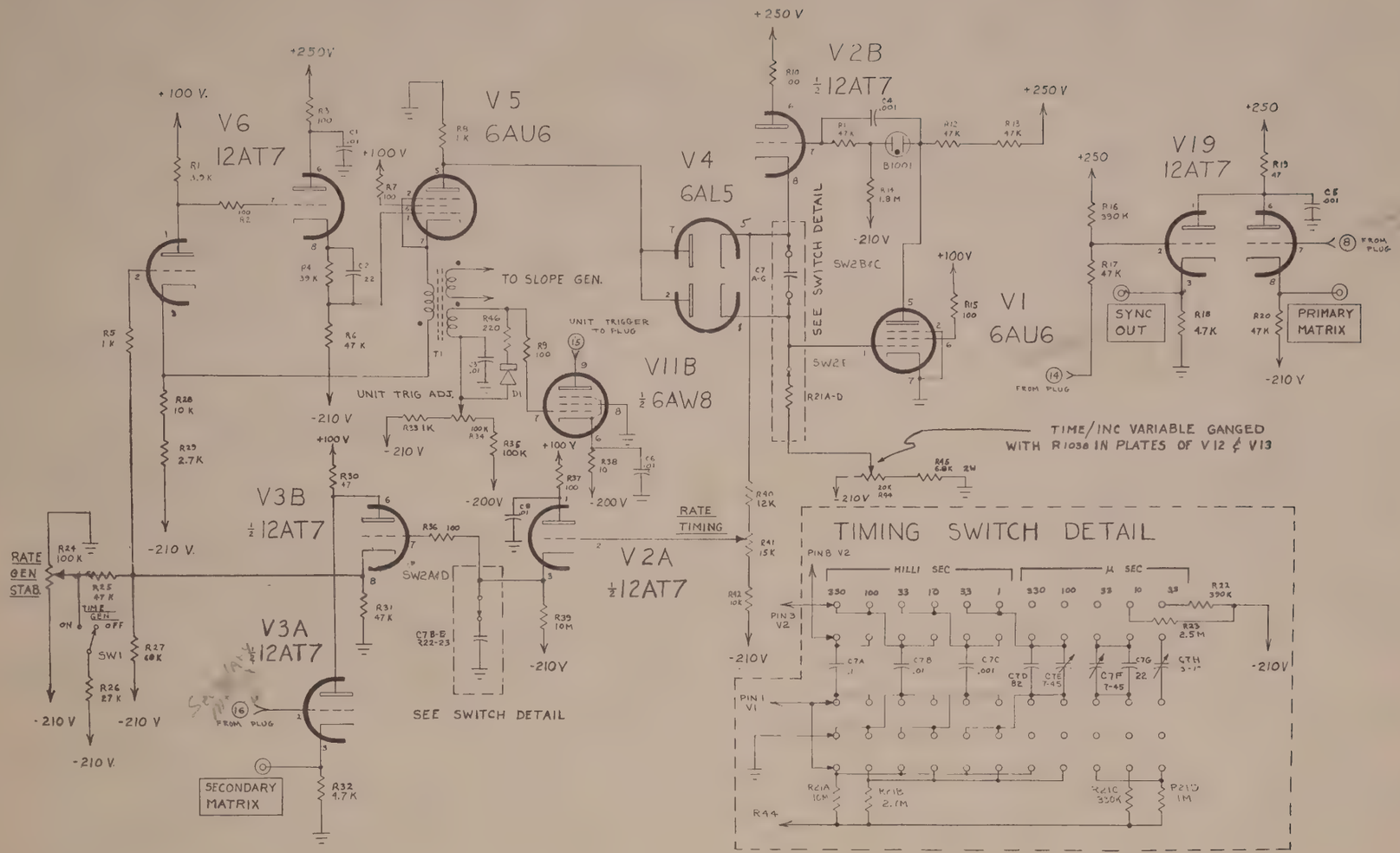
Q. Re-check all MATRIX controls for lack of interaction and full range.

BLOCK DIAGRAM

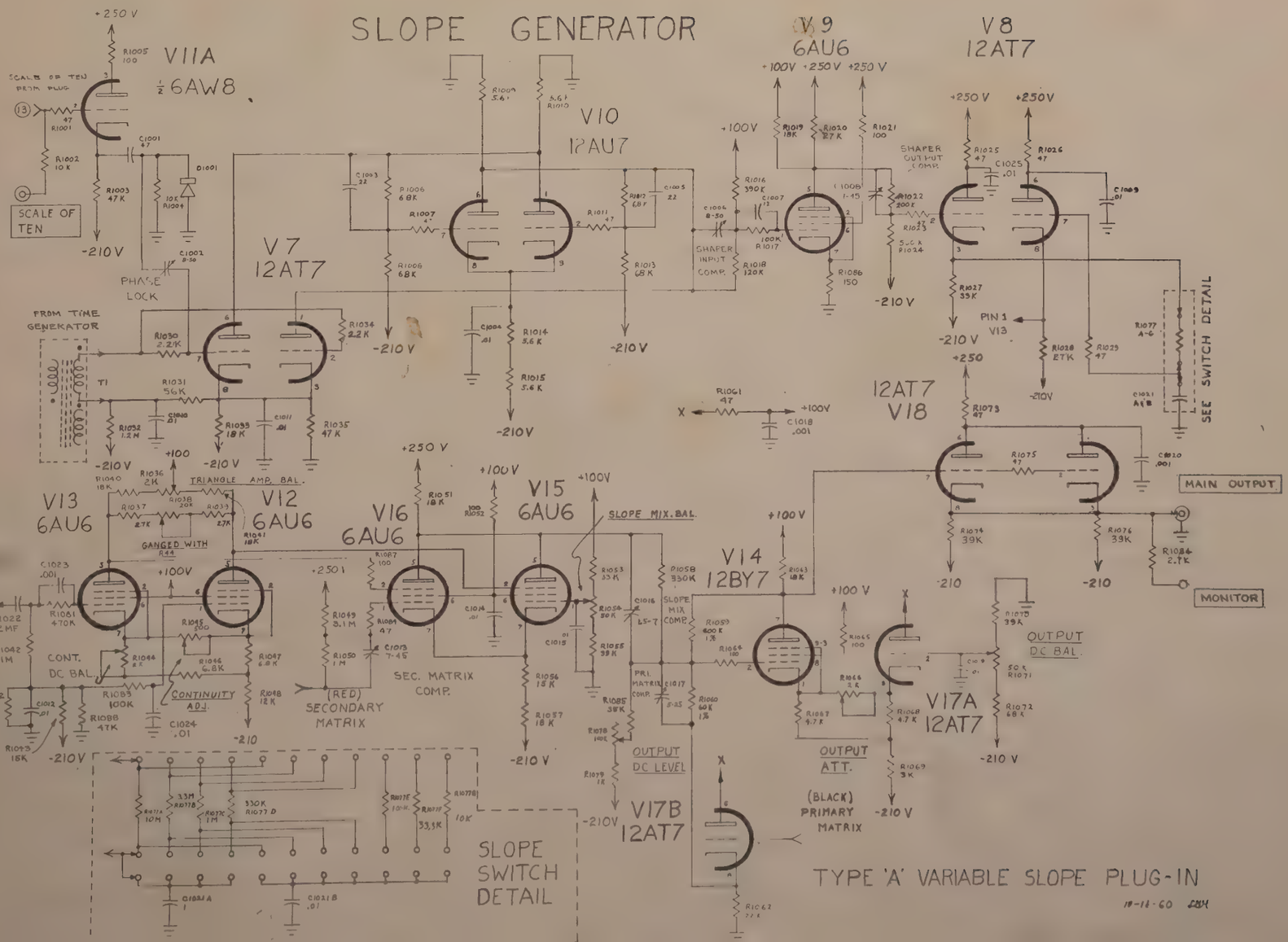


TYPE 200 WAVEFORM SYNTHESIZER

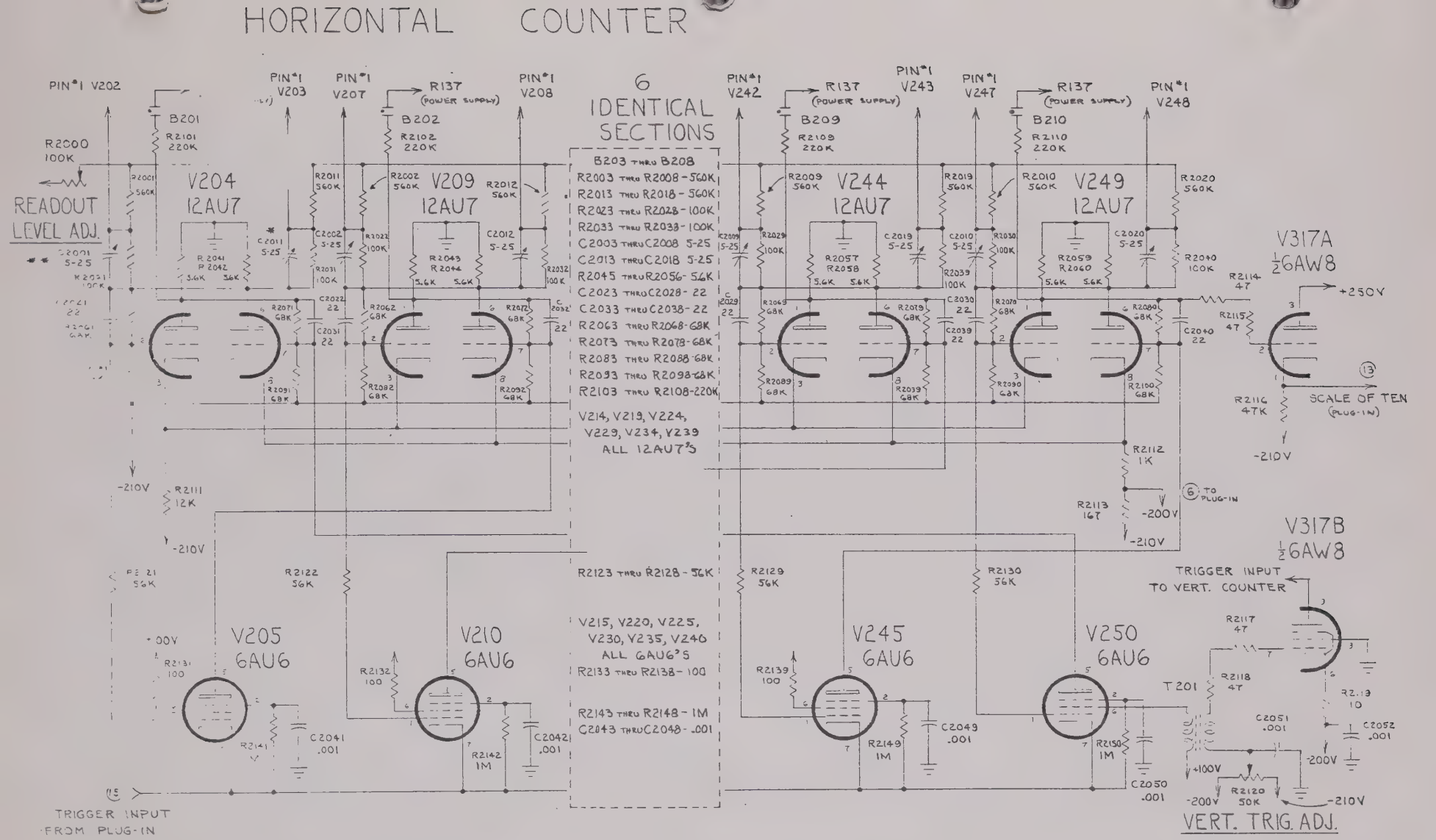
TIME GENERATOR



SLOPE GENERATOR



HORIZONTAL COUNTER

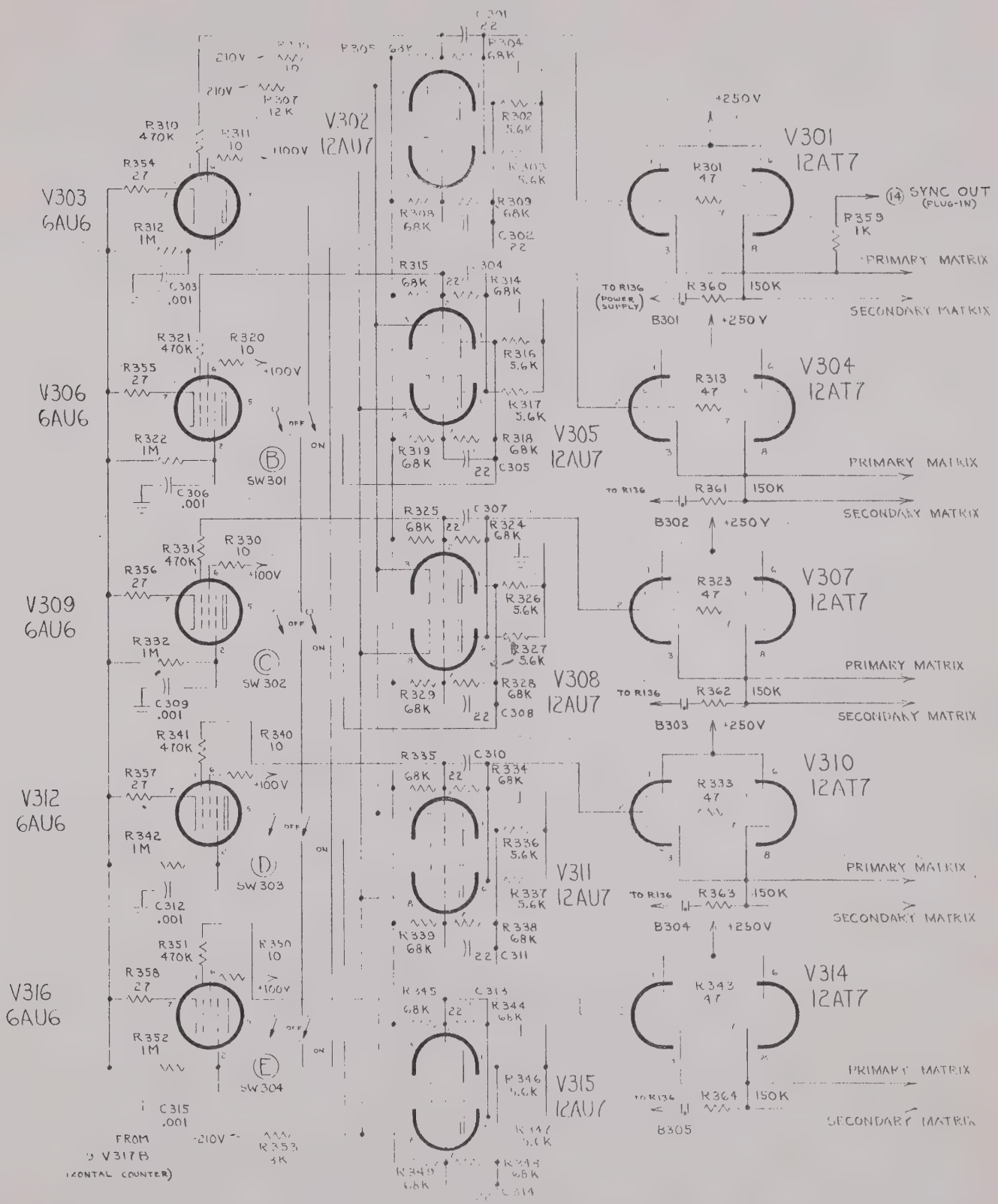


** C2001 THRU C2010 ARE PRIMARY. READOUT COMP.

* C2011 THRU C2020 ARE SECONDARY READOUT COMP.

TYPE 200 WAVEFORM SYNTHESIZER 1-23-60 CAT

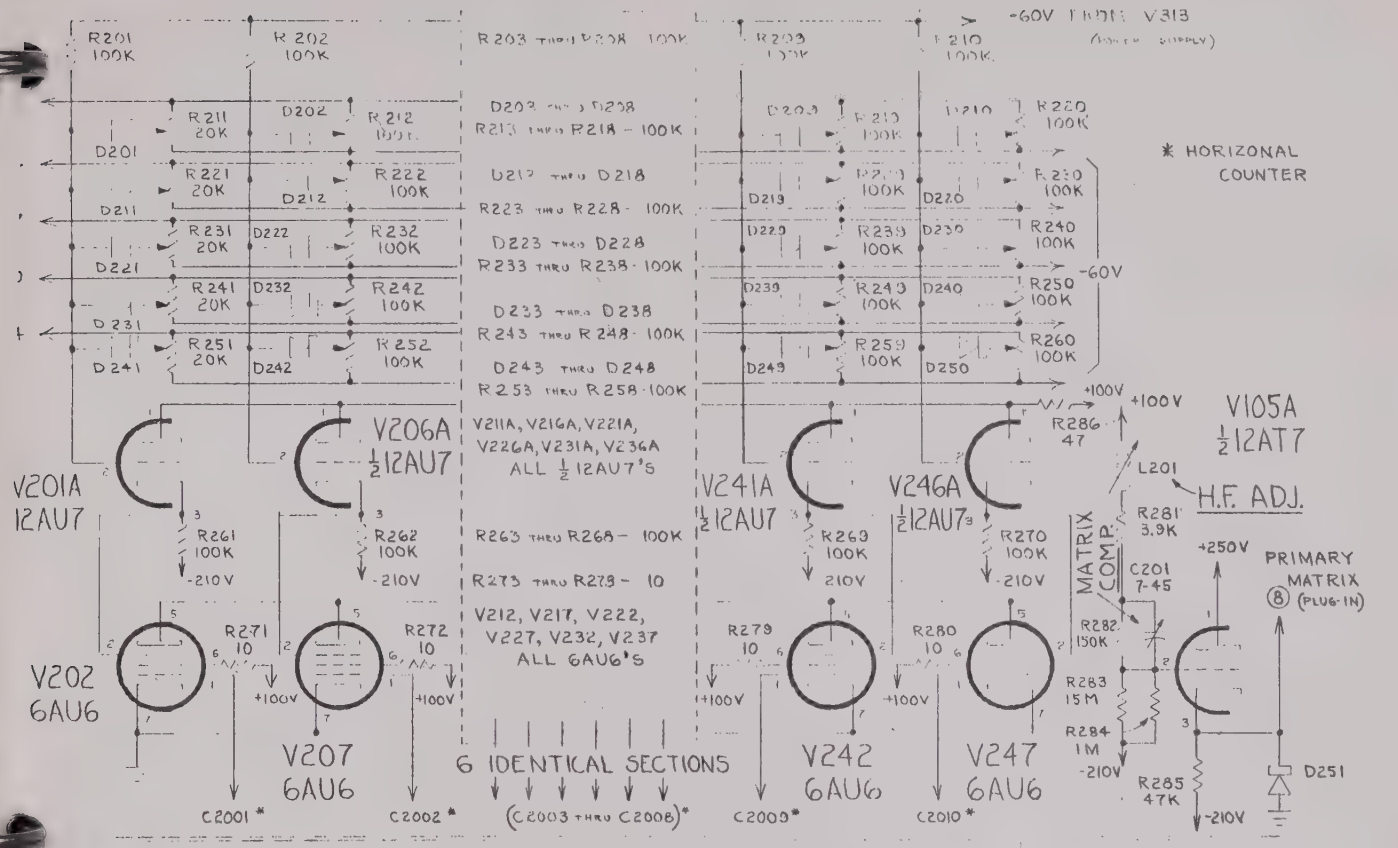
VERTICAL COUNTER



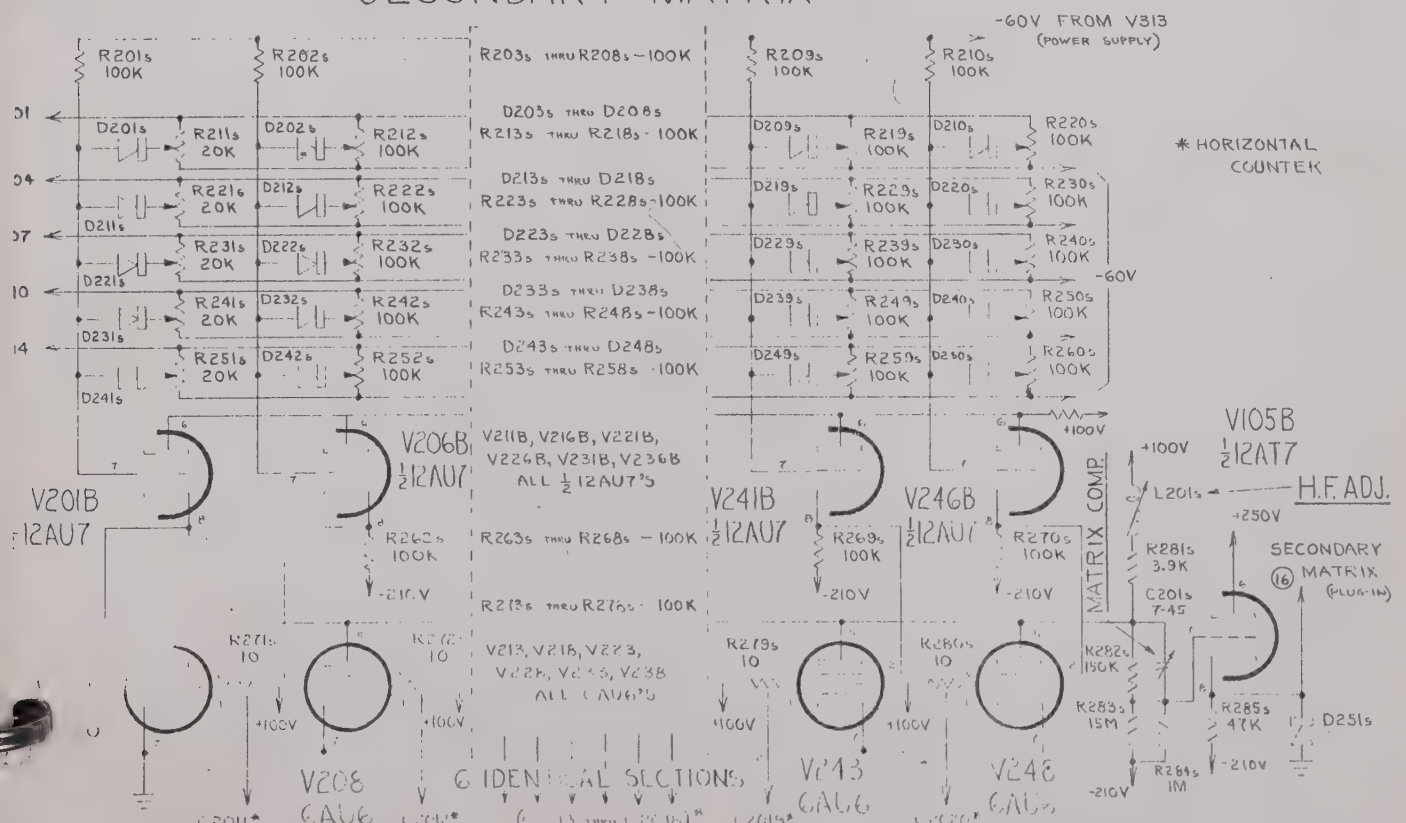
TYPE 600 WAVEFORM SYNTHESIZER

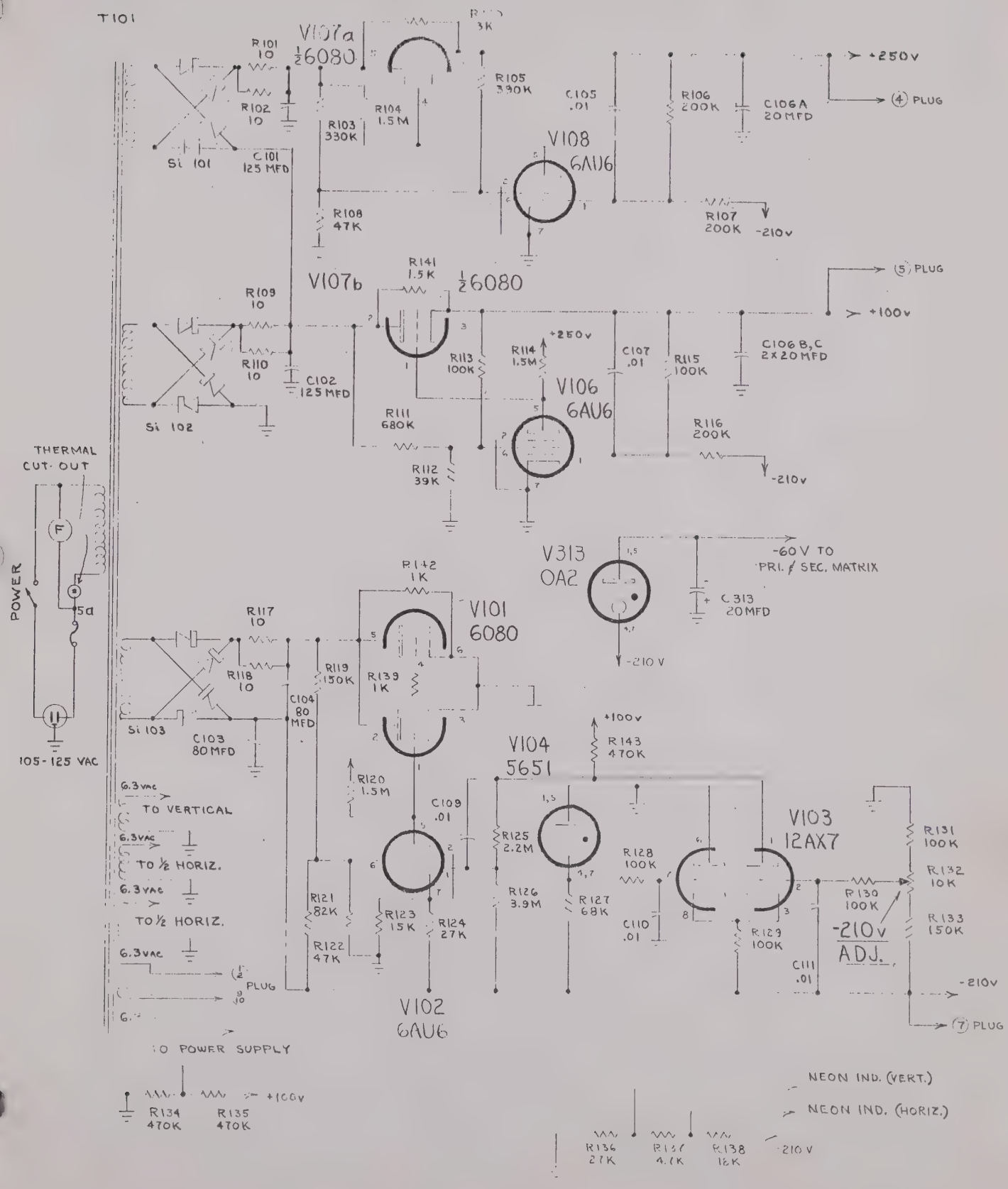
Notes: All diodes on schematic on opposite page are connected with the anode to the center of the potentiometer (D201 - D250 & $D201_s$ - $D250_s$)

PRIMARY MATRIX



SECONDARY MATRIX




POWER SUPPLY
T101
V107a
½6080
R101
10
R102
10
Si 101
C101
125 MFD
R103
330K
R104
1.5M
R105
390K
R108
47K
V108
6AU6
C105
.01
R106
200K
C106A
20MFD
+250v
④ PLUG
R107
200K
-210v
V107b
½6080
R141
1.5K
R109
10
R110
10
Si 102
C102
125 MFD
R111
680K
R112
39K
R113
100K
R114
1.5M
+250v
V106
6AU6
C107
.01
R115
100K
C106B,C
2x20MFD
⑤ PLUG
+100v
R116
200K
-210v
THERMAL
CUT-OUT
POWER
105-125 VAC
V313
OA2
-60V TO
PRI. & SEC. MATRIX
C313
20MFD
-210 V
R142
1K
V101
6080
R117
10
R118
10
Si 103
C103
80 MFD
R119
150K
C104
80
MFD
R139
1K
R120
1.5M
V104
5651
+100v
R143
470K
C109
.01
R125
2.2M
R126
3.9M
R127
68K
R128
100K
C110
.01
V103
12AX7
R129
100K
R130
100K
R131
100K
R132
10K
R133
150K
-210v
ADJ.
C111
.01
-210v
⑦ PLUG
6.3vac
TO VERTICAL
6.3vac
TO ½ HORIZ.
6.3vac
TO ½ HORIZ.
6.3vac
PLUG
R121
82K
R122
47K
R123
15K
R124
27K
V102
6AU6
TO POWER SUPPLY
R134
470K
R135
470K
+100v
NEON IND. (VERT.)
NEON IND. (HORIZ.)
R136
27K
R137
4.7K
R138
18K
-210 V

TYPE A
VARIABLE SLOPE GENERATOR

OPERATING INSTRUCTIONS

I. FRONT PANEL FAMILIARITY

A. OUTPUTS

1. The MAIN OUTPUT comes from cathode follower V18 and contains 10-20-30-40 or 50 increments each individually variable in amplitude and slope. Maximum available output power is 50V at 10 ma.

2. The MONITOR OUTPUT is identical to the MAIN OUTPUT and is isolated from it by a separate cathode follower.

3. The PRIMARY MATRIX OUTPUT comes from cathode follower V19 and contains the same number of increments with the same time base as the MAIN OUTPUT. Each increment is variable in amplitude only by the PRIMARY MATRIX knobs.

4. The SECONDARY MATRIX comes from cathode follower V3A. It is independent from the PRIMARY MATRIX, but also has the same number of increments with the same time base as the MAIN OUTPUT. Each increment is variable in amplitude only by the SECONDARY MATRIX knobs.

5. The SYNC OUT is derived from the cathode of V301 in the VERTICAL COUNTER. It is a 30V gate with a time duration equivalent to the time which row A is turned on (10 increments).

6. The SCALE OF TEN out is derived from cathode follower V317B in the HORIZONTAL COUNTER and is coincident with the tenth HORIZONTAL COUNTER pulse. It is a 40 volt gate acquiring every tenth increment and having a duration equal to one increment.

B. OUTPUT AMPLITUDE

This control, R1066, is located in the cathode circuit of V14 and V17A, and adjusts the gain of this stage over approximately a 3 to 1 range.

C. TIME/INCREMENT switch

Located in the grid circuit of V1, V2A, and V8A; this switch determines the time of the Miller trigger generator, trigger hold-off circuits and slope generator.

D. TIME/INCREMENT VARIABLE

This control, R44 is located in the grid circuit of V1 and permits a vernier adjustment to continuously cover all ranges set by the TIME/INCREMENT switch.

I. FRONT PANEL FAMILIARITY (continued)

E. TRIGGER GENERATOR

This two position rotary switch is located in the grid circuit of V6 and determines whether the trigger generator will be free-running at the desired rate or completely inoperative.

V. WAVEFORM CONTINUITY

The control, R1045 is located in the CATHODE CIRCUITS of V12 and V13. It provides adjustment to compensate for slight over-all waveform discontinuities when switching varies. Normal setting is at zero (midrange).

II. TYPICAL OPERATION

Connect the SYNC OUT from the TYPE "A" to the oscilloscope trigger input or to the system input to be triggered. Connect the MAIN OUTPUT to the circuit, system or instrument under test and the MONITOR output to the oscilloscope input.

Turn the TRIGGER GENERATOR to ON and set the TIME/INCREMENT switch to the desired increment duration desired.

Check the row switches on the Type 200 for the number of increments you want the total waveform to contain.

Adjust each PRIMARY MATRIX knob (black) for the increment amplitude desired, then adjust the concentric SECONDARY MATRIX knob (red) for the needed amount of slope. Each pair of PRIMARY and SECONDARY adjustment should be made until the total required output waveform is achieved. The TIME/INCREMENT range or OUTPUT AMPLITUDE may now be varied without any loss in relative shape of the output.

If the increments appear to have drifted slightly apart when you have changed ranges, adjustment of WAVEFORM CONTINUITY should return them to the original setting.

TYPE A CIRCUIT DESCRIPTION

I. TIME GENERATOR

A. MILLER TIME BASE (V1, V2B, V4, V5 and V6)

A Miller run-up sawtooth generator (V1 and V2B) is used as a time base. Operation of the generator is controlled by a Schmidtt Circuit (V5 and V6) switching the disconnect diodes (V4) on and off. This switching action determines the start and stop of each individual sawtooth.

Time ranges are determined by the capacitor (C7) and resistor (R21) switched in by the TIME/INC RANGE switch (Front Panel). The VARIABLE control R44 varies the changing voltage over a small range for vernier action.

B. RATE TIMING

Time rate is calibrated by adjusting R41, RATE TIMING control. This control varies the amplitude of the sawtooth appearing on pin 2 and pin 3 of V2A. This, in turn, varies the time it takes for pin 7 of V3B to rise above the cathode voltage (pin 8) and pull up the cathode. Since pin 8 of V3B causes pin 2 of V6 to rise, it can flip the Schmidtt Circuit (V5 and V6) re-setting the sawtooth generator.

Since the timing capacitor (C7) takes a finite time to discharge, the grid of V3B (pin 7) is delayed in its fall by a hold-off capacitor, the Schmidtt Circuit (V5 and V6) will therefore not be restored until this capacitor has discharged.

C. TRIGGER PULSE GENERATION (V5)

Simultaneous trigger pulses for the SLOPE GENERATOR and HORIZONTAL COUNTER are obtained from a toroid transformer Ti in cathode circuit of V5.

D. HORIZONTAL TRIGGER ADJUST (V11B)

HOR TRIG ADJUST varies the bias on the grid of V11B (pin 7). This controls the amplitude of the negative pulse appearing on the plate pin 9 used for triggering the HORIZONTAL COUNTER in the TYPE 200.

E. OUTPUT CATHODE FOLLOWERS (V19A, V3A, V19B)

Cathode followers provide isolated outputs to the front panel for SYNC, PRIMARY MATRIX and SECONDARY MATRIX.

II. SLOPE GENERATOR

A. SQUARE WAVE GENERATOR (V7, V9 and V10)

The slope trigger pulse is amplified by V7. Since the plates (pins 6 and 1) are tied to the plates of the bi-stable multivibrator V10, each pulse reverses the condition of V10, producing a symmetrical square wave on pin 6.

The square wave is shaped and amplified by V9.

B. TRIANGLE GENERATOR (V8)

The symmetrical square wave is integrated by R1077 and C1021 in the cathode circuit of V8A (pin 3).

A cathode follower (V8B) is used for the output of the triangle waveform.

C. TRIANGLE AMPLIFIER AND INVERTER (V12 and V13)

A paraphase amplifier (V12 and V13) produces two amplified triangle waveforms that are 180° out of phase with each other.

The degeneration control R1045 controls the relation amplification of each tube for CONTINUITY ADJUST. CONTINUITY BAL ADJ, R1042 adjusts the DC level of V13 cathode (pin 7) equal to that of V12 cathode (pin 7).

This prevents a DC shift when the CONTINUITY ADJ is varied.

R1038 in the plate circuit is gauged with the VARIABLE TIME/INC CONTROL to maintain proper slope amplitude when time is changed.

TRIANGLE AMP BAL, R1036, is adjusted for equal DC levels on plates of V12 and V13.

D. SLOPE MIXER (V15 and V16)

The two out-of-phase triangle waveforms are fed to the suppressors (pins 2) of the mixer circuit (V15 and V16).

Since the SECONDARY MATRIX waveform is connected to the grid (pin 1) of V16, variations in increment level will determine the relative amplification of each of the out-of-phase triangle waveforms. (SLOPE MIX BAL control sets the DC level of the grid of V15 equal to that of V16).

The common output of V15 and V16 consists of slopes that vary in degree according to the levels of the SECONDARY MATRIX waveform.

E. OUTPUT (V17B, V14, V17A, V18)

Mixing of the PRIMARY MATRIX increment levels with the slopes is accomplished by the network in the grid circuit of V14 (pin 2). OUTPUT DC LEVEL, R1078, sets the DC level of the composite waveform.

The OUTPUT ATTENUATOR, ~~R1065~~ R1066, varies the gain of V14 and consequently the amplitude of the output waveform.

Cathode of V17A (pin 3) is adjusted to the same DC level as the cathode of V14 (pin 1) by the OUTPUT DC BAL, R1071. This prevents any DC shift during operation of the OUTPUT ATT.

Cathode followers V18A and V18B provide isolated outputs for the MONITOR and MAIN OUTPUT.

F. SLOPE PHASE LOCK (V11A)

This circuit prevents the slopes from reversing by insuring that the bi-stable multivibrator, V10, does not operate 180^{o} out of phase. (The multi can start in either mode when the instrument is turned on).

The scale-of-ten pulse is differentiated and the negative portion clipped in the cathode circuit of V11A. This pulse is coupled through variable capacitor C1002 to the input of the trigger tube V7. The pulse is of sufficient amplitude to force V10 to lock in phase, regardless of how it starts.

CALIBRATION PROCEDURE FOR EXACT

TYPE A VARIABLE SLOPE PLUG - IN

TEST EQUIPMENT REQUIRED

1. An oscilloscope with a response of DC to 5 MCS or better; sensitivity of 1 volt/cm.
2. Volt/Ohm Meter of 20,000 ohms/volt
3. Screwdriver with insulated shaft

POWER OFF (plug-in out of instrument)

1. VISUAL INSPECTION
2. POWER LOAD RESISTANCES
   - A. Using ohmmeter, measure resistance from voltage lead to ground:
     1. -210 Volt (approximately 7KΩ)
     2. -200 Volt (approximately 200K)
     3. +100 Volt (approximately 70K)
     4. +250 Volt (approximately 90K)

POWER ON (plug-in placed in instrument. Power turned on)

TIME GENERATOR

1. RATE GENERATOR STABILITY
   - A. Monitor pin 5 of V4 with test oscilloscope (if no signal is observed, check to see that front panel TIME GEN switch is on).
   - B. Adjust RATE GEN. STABILITY for stable sawtooth pattern which disappears when front panel TIME GEN switch is turned off.
2. TIMING ADJUST
   - A. While still observing sawtooth pattern on pin 5 of V4, turn front panel TIME/INC switch to 1 millisec/INC position. (VARIABLE control fully clockwise)
   - B. Check for 1 sawtooth/millisec. If required, adjust RATE TIMING (R41).
   - C. Check time in all ranges of TIME/INC switch except 8/4 fastest positions.

3. H.F. TIMING

A. With TIME/INC switch in ~~10~~ 100 μsec/INC position, adjust C7E (mounted on switch) for correct time.

B. Check timing in ~~33~~ 330 μsec/INC position (C7E adjusts for this position also).

C. With TIME/INC switch in ~~3~~ 33 μsec/INC position, adjust ~~C7G~~ C7F for correct time.

4. VARIABLE TIME CONTROL ★ See Below

A. Check the front panel VARIABLE TIME CONTROL for 3 to 1 range.

TRIGGER OUTPUTS

1. HORIZONTAL TRIGGER OUTPUT

A. With test oscilloscope monitoring pin 7 of V11B, observe positive trigger pulse of approximately 8 volts amplitude.

NOTE: PULSE IS NARROW AND FAST. TURN UP INTENSITY ON TEST OSCILLOSCOPE

2. SLOPE TRIGGER OUTPUT

A. Observe pin 7 of V7 with test oscilloscope for presence of positive slope trigger pulse of approximately 5 volts amplitude.

3. HORIZONTAL TRIGGER ADJUST

A. With test oscilloscope monitoring PRIMARY MATRIX (front panel output jack), adjust HOR TRIG control for correct output.

Best procedure is to switch off all but top row of knobs on instrument. Adjust for stable pattern of 10 increments. Turn all rows back on, check for 50 increments.

SLOPE GENERATOR

1. SQUARE WAVE GEN OUTPUT

A. Observe pin 3 of V8 with test oscilloscope. A symmetrical square wave should be seen. Center of waveform should be at approximately ground level.

B. If required, adjust C1006 and C1008 for minimum spike and flattest top. These adjustments are best made with TIME/INC switch in the 330μsec/INC position.

★ D. Check timing in 33 μsec position
E. With TIME/INC Switch in 3.3 μsec position, Adj. C7H for correct time.

2. TRIANGLE GENERATOR

A. A triangle waveform should be observed at pin 8 of V8.

3. TRIANGLE AMP BALANCE

A. Using test oscilloscope, observe plates of V12 and V13 (pins 5). (Front panel VARIABLE time control should be clockwise; CONTINUITY ADJ at zero).

D.C. levels of waveforms should be the same.

B. If D.C. levels are different, try interchanging V12 and V13 to see if tubes are not balanced.

C. If necessary, adjust TRIANGLE AMP BAL so both waveforms have same D.C. level

NOTE: If dual channel oscilloscope is available, it is easier to make adjustment by monitoring both waveforms simultaneously and superimposed on each other.

4. SLOPE MIXER

A. Observe waveform on pin 5 of V16. Turn slopes so they are all slanting in the same direction by manipulating knobs on front of instrument.

B. Although slight difference in amplitude of slopes may be present, they should be in alignment with each other. (adjust C1013 for best linearity or minimum spike if required).

C. If slopes are not in alignment, adjust SLOPE MIXER BAL for best alignment without distortion (interchange V15 and V16 first to see if tubes are out of balance).

OUTPUT

1. OUTPUT LEVEL AND ATTENUATOR BAL

output level CW

A. Monitor front panel OUTPUT with test oscilloscope. Adjust several rows of front panel black knobs to alternately maximum and minimum settings.

B. Adjust OUTPUT LEVEL for D.C. level of "ground potential" at center of waveform.

C. While rotating front panel OUTPUT ATTENUATOR control back and forth, adjust OUTPUT DC BAL for minimum D.C. shift.

NOTE: OUTPUT D.C. BAL and OUTPUT LEVEL controls have interaction. Readjustment of both several times may be required for optimum settings.

Adjustment should be made without causing distortion of waveform.

2. MATRIX MIXING COMPENSATING CAPACITORS

A. Monitor front panel OUTPUT with instrument in 330μsec/INC position. Adjust several increments to mid-range with flat tops.

B. If necessary, adjust C1016 and C1017 for minimum spike and flattest tops.

SLOPE PHASE LOCK ADJ (V11A, C1002)

1. If all slopes should reverse direction 180° at any time during use of instrument, adjustment of C1002 is indicated.

A. Monitor OUTPUT with test oscilloscope. Time/INC or 330μsec/INC. Turn a number of slopes all one direction.

B. Turn C1002 to minimum setting. Using tip of screwdriver, quickly tap plate circuit of V10 (pin 1 or 5) several times until you observe slopes reverse 180°.

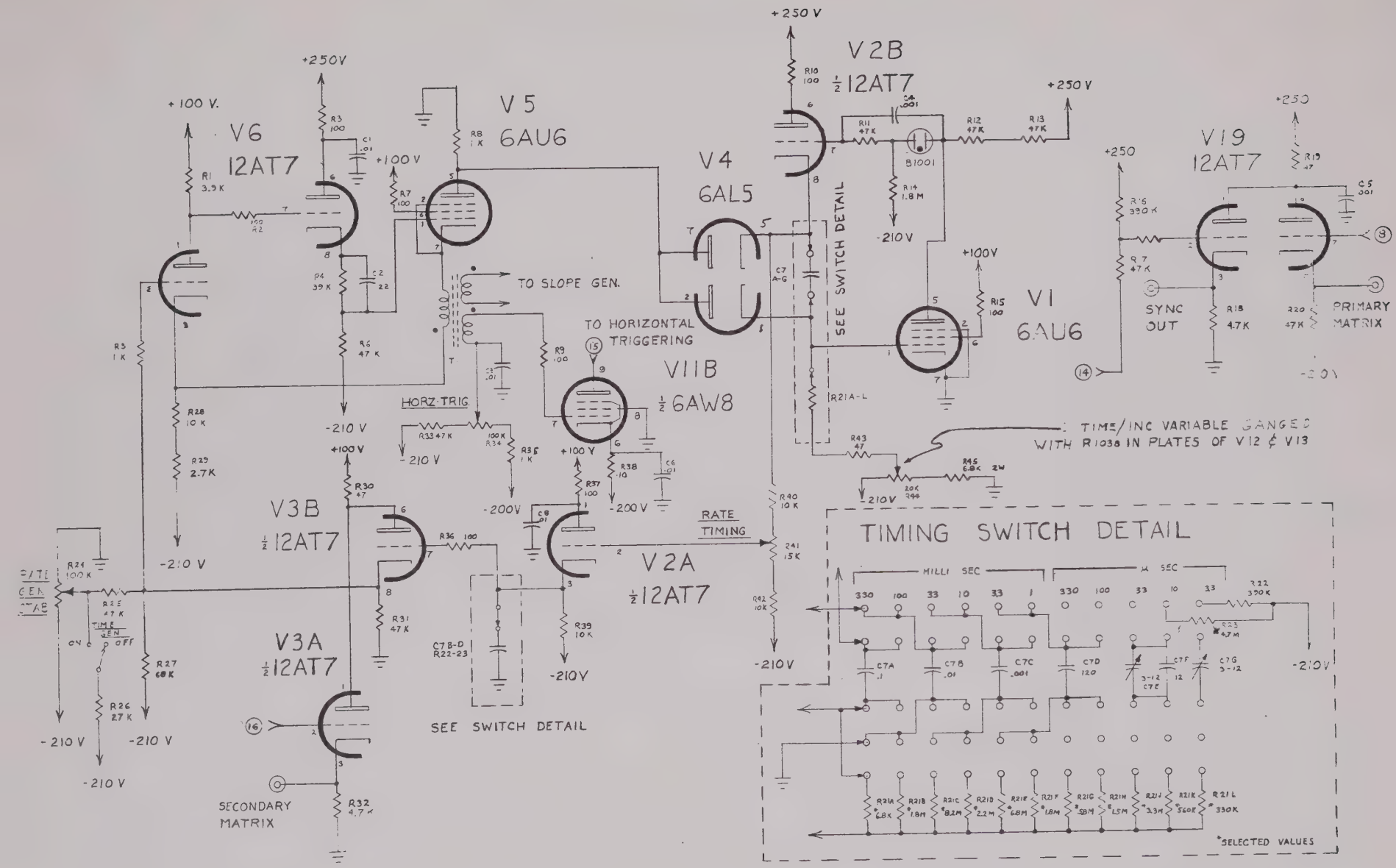
C. Turn C1002 until slopes flip back to normal. Increase capacitor setting a very small amount more.

NOTE: If slopes do not flip, repeat Step B.

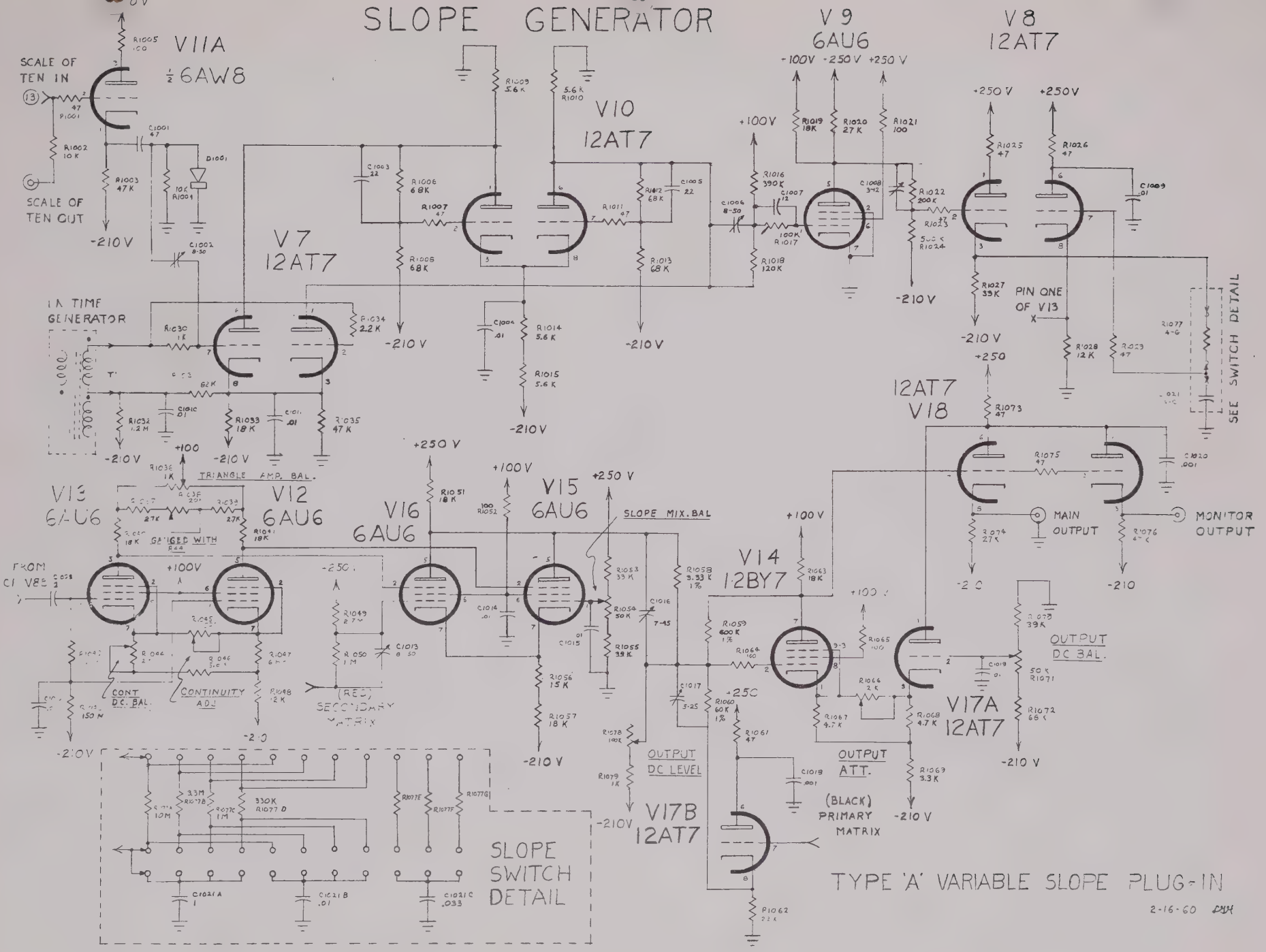
D. Check OUTPUT waveform at fast speeds.

If C1002 is set too high, distortion or time irregularities will occur at faster rates.

TIME GENERATOR



TYPE 'A' VARIABLE SLOPE PLUG-IN 1-23-60 PAT


SLOPE GENERATOR
V11A
½ 6AW8
SCALE OF TEN IN
SCALE OF TEN OUT
-210 V
V7
12AT7
V10
12AT7
V9
6AU6
+100V -250V +250V
V8
12AT7
+250V +250V
1A TIME GENERATOR
TRIANGLE AMP. BAL.
V13
6AU6
V12
6AU6
V16
6AU6
V15
6AU6
SLOPE MIX. BAL
V14
12BY7
12AT7
V18
+250
MAIN OUTPUT
MONITOR OUTPUT
PIN ONE OF V13
SEE SWITCH DETAIL
FROM C1 V8B
GANGED WITH R44
CONT DC. BAL.
CONTINUITY ADJ.
(RED) SECONDARY MATRIX
OUTPUT DC BAL.
OUTPUT DC LEVEL
OUTPUT ATT.
V17A
12AT7
V17B
12AT7
(BLACK) PRIMARY MATRIX
SLOPE SWITCH DETAIL
TYPE 'A' VARIABLE SLOPE PLUG-IN
2-16-60

TYPE C
VARIABLE WIDTH GENERATOR

OPERATING INSTRUCTIONS

I. FRONT PANEL FAMILIARITY

A. OUTPUTS

1. The MAIN OUTPUT provides 10-20-30-40 or 50 increments each individually variable in width and amplitude. The maximum available output power is 50 volts at approximately 20 ma.

2. The MONITOR output is identical to the MAIN OUTPUT but is isolated by a 1.8 K 1 watt resistor in series with it.

3. The TRIGGER OUT is a 20 volt pulse gate, positive-going from ground. It occurs while the A row is turned ON.

   In LOCKOUT position the TRIGGER OUT pulse is obtained from the LOCKOUT circuit.

   NOTE: IF ONLY ONE ROW IS TURNED ON, IT IS NECESSARY TO USE THE SCALE OF TEN OUT FOR TRIGGERING.

4. The SCALE OF TEN OUT is a 30 volt pulse, positive-going from -30 volts to ground. It occurs in coincidence with the tenth increment of each HORIZONTAL row.

B. CONTROLS

1. The OUTPUT AMPLITUDE controls the amplitude of the output signal. When rotated from full clockwise to counter-clockwise position the output will be attenuated by a ratio of approximately 3 to 1.

2. The TIME/INCREMENT switch determines the minimum time that an increment may have. The SECONDARY MATRIX (red) knobs can expand the increment duration up to 10 times the minimum time.

3. The TRIGGER SOURCE switch determines whether the rate generator is internally or externally triggered.

4. The TRIGGER MODE switch controls the LOCKOUT features of the rate generator.

   a. In the NORM. position the rate generator runs continuous (or with external triggering).

I. FRONT PANEL FAMILIARITY (continued)

b. In the 10 COUNT position, the rate generator will generate one row of 10 increments and then lockout on the first increment of the next switched-on row.

c. In the PROGRAM COUNT position, the rate generator will generate all increments that are turned on, once, and then will lockout on the first increment of the A row.

5. The MANUAL TRIGGER button may be used to trigger the instrument manually. Pressing the MANUAL TRIGGER button will cause triggering by increments, one at a time.

6. The RESET button is used for resetting the LOCKOUT.

C. INPUTS

1. The TRIGGER INPUT requires a 20 to 60 volt trigger with a relatively fast risetime. In the NORM. position this input provides for externally triggering each increment.

When the TRIGGER MODE switch is in the 10 COUNT or PROGRAM COUNT position, this external trigger may be used as a LOCKOUT reset.

II. TYPICAL OPERATION

A. MONITORING THE OUTPUT WITH OSCILLOSCOPE

1. Connect the TRIGGER OUT to the external trigger input on the oscilloscope. (+ position)

2. Connect the MONITOR output to the vertical input on the oscilloscope. Use a ground lead between the two instruments to complete circuit.

3. Set the gain of the oscilloscope for about 10 volts/division and the sweep time for about 50 times the incremental time indicated on the TIME/INCREMENT switch.

B. OPERATING THE C PLUG-IN UNIT

1. Apply power to the Type 200.

2. Plug in the C unit. Turn the TRIGGER SOURCE to INTERNAL position.

3. Check the row switches for the number of increments you want the total waveform to contain.

II. TYPICAL OPERATION (continued)

4. Set the TIME/INCREMENT switch to the desired incremental time.

5. Turn the TRIGGER MODE switch to the NORM. position.

6. Adjust the oscilloscope to obtain the MONITOR output on its screen.

7. To adjust the amplitude of each increment, use the PRIMARY MATRIX (black) knobs. The first pulse seen on the oscilloscope should be the number one position on the A row. If not . . . . readjust triggering of oscilloscope.

8. To adjust the width of each increment use the SECONDARY MATRIX (red) knobs.

C. USING THE LOCKOUT POSITIONS ON THE TRIGGER MODE SWITCH

1. 10 COUNT POSITION

a. Turn the TRIGGER MODE switch to the 10 COUNT position.

b. Sharply push the RESET button. The VERTICAL should drop down one row after the HORIZONTAL runs through its tenth count. This will be indicated by the extinguishing of the first HORIZONTAL neon bulb and the igniting of the next VERTICAL neon bulb.

If all the rows are switched ON, then it will take five pushes on the RESET button to complete a full cycle.

2. PROGRAM COUNT POSITION

a. Turn the TRIGGER MODE switch to the PROGRAM COUNT position.

b. Sharply push the RESET button. The instrument should run through one complete cycle (all rows that are switched ON) and then lockout at the number one position of row A.

In the three fastest ranges on the TIME/INCREMENT switch, lockout may occur at the second position of row A.

3. EXTERNAL RESET

a. To externally reset the LOCKOUT, apply a square wave or pulse of 20 to 60 volts amplitude to the TRIGGER INPUT. The pulse should have a fast risetime on the order of .05 microseconds or so. The period between the pulses should be longer than the period of the program.

II. TYPICAL OPERATION (continued)

4. MANUAL TRIGGERING

a. The synthesizer may be triggered manually (MANUAL TRIGGER button) when the TRIGGER SOURCE is in the EXTERNAL position. Pressing the MANUAL TRIGGER button will cause triggering by increments, one at a time.

The unit can also be manually triggered by increments in the LOCKOUT positions. Of course lockout will occur and the RESET button will have to be pushed.

TYPE C
PLUG-IN CIRCUIT DESCRIPTION

I. TIME/INCREMENT GENERATOR

A. MILLER TIME BASE GENERATOR (V1, V2, V3, V4, V5 and V6)

V1 is a Miller Run-up sawtooth generator which is gated by a Schmidtt multivibrator (V5 and V6) through the disconnect diode (V4). The feedback path through V2, R41 and V3, determines the amplitude of the Miller's Run-up.

B. RATE TIMING

The time rate is determined by the capacitors C19 A to K and the variable-current pentode V13. (These capacitors are matched to within ±1% at the factory.)

The SECONDARY MATRIX is used to control the current in the pentode V13 by means of the cathode follower V11. The plate current of this pentode may be changed by a factor of 10 times. This gives the matrices the possibility of varying their widths by a factor of 10.

The RATE TIMING control (R50) sets the operating point of V13 and is used for calibration.

C. RATE GEN. STABILITY

When the TRIGGER SOURCE switch is in the INTERNAL position, the RATE GEN. STABILITY is adjusted so the rate generator is self-triggering.

When the switch is in the EXTERNAL position, external or manual triggering is required to operate the rate generator. This is accomplished by disengaging the cathode resistor R74 on the feedback loop (V3, V7B, V8B).

D. HORIZONTAL TRIGGER PULSE GENERATION (V5)

The HORIZONTAL TRIGGER pulses are generated in the cathode circuit of V5 by means of the pulse transformer T1. A positive-going pulse appears on the secondary of T1, each time the Miller sawtooth generator is gated off by V5 through diode V4.

The HORIZONTAL ADJ. adjusts the DC level of the pulse fed to the grid (pin 7) of V7A. The pentode V7A gates current to the trigger tube of the HORIZONTAL in the Type 200 via pin 6 on the plug-in connector. These are negative-going pulses.

I. TIME/INCREMENT GENERATOR (continued)

E. LOCKOUT (V8 and V9)

The LOCKOUT circuit consists of tubes V8 and V9. Lockout occurs when pin 9 of V8B is held at about 0 volts. This condition exists when the TRIGGER MODE switch is in either of the LOCKOUT positions.

In the 10 COUNT position, the SCALE OF TEN gate is fed to the grid (pin 2) of V8A. In the PROGRAM COUNT position, a gate from the VERTICAL is used in place of the SCALE OF TEN.

The negative portion of the pulse gate is clipped and shaped by the diode. It is then differentiated by C3, R18 and R20.

The positive portion of the differentiated pulse is amplified by V8A and used to flip the bistable multi (V9) to the LOCKOUT position. Switch SW2B prevents the LOCKOUT from working in the NORM. position. The LOCKOUT can be reset manually or by an external trigger.

F. VARIABLE WIDTH GENERATION

The variable width action is created by replacing the usual timing resistors in the grid of the Miller sawtooth generator with a pentode (V13) and operating its control grid with the output of the SECONDARY MATRIX.

The plate current of V13 can be varied by a factor of 10. This adjustment is controlled by the setting of RATE TIMING (R50).

G. OUTPUT

The OUTPUT consists of the PRIMARY MATRIX amplified to 50 volts by V14 and V12B. The amplitude is varied by the OUTPUT AMPLITUDE control (R62) in the cathode of the amplifier circuit. A cathode follower (V15) provides isolation for the MONITOR AND MAIN OUTPUT.

CALIBRATION PROCEDURE OF EXACT

TYPE C VARIABLE WIDTH PLUG-IN

The following is a factory calibration procedure and should rarely, if ever, need to be completely duplicated once the instrument is in operation. It is furnished for your assistance in recalibrating certain sections after you have made a major repair, or when checking operation during preventive maintenance.

TEST EQUIPMENT REQUIRED

1. An oscilloscope with a response of DC to 5-MCS. or better; sensitivity of 50 MV/division. Sweeps should be calibrated to within 1%.

2. Volt/Ohm Meter of 20,000 ohms/volt.

3. Screwdriver with insulated shaft.

POWER OFF (plug-in out of instrument)

1. Visual inspection.

2. Power load resistances.

   A. Using ohmmeter, measure resistance from plug-in connector terminal to ground:

      1. -210 Volt, terminal #7 (approximately 30K ohm)
      2. -200 Volt, terminal #6 (approximately 50K Ω)
      3. +100 Volt, terminal #5 (approximately 25K Ω)
      4. +250 Volt, terminal #4 (approximately 100K Ω)

POWER ON (plug-in placed in instrument. Power turned on.)

TIME/INCREMENT GENERATOR

1. RATE GEN. STABILITY

   A. Monitor pin 3 of V2 with the test oscilloscope.

   B. Adjust RATE GEN. STABILITY so that the rate generator will run in the INTERNAL position of the TRIGGER SOURCE switch but not the EXTERNAL position.

      NOTE: SOME OF THESE ADJUSTMENTS MAY REQUIRE RETOUCHING DURING CALIBRATION BECAUSE OF INTERACTION.

TYPE C CALIBRATION PROCEDURE (continued)

2. SECONDARY MATRIX COMPENSATION

A. Monitor pin 7 of V11 with test oscilloscope.

B. Adjust several red knobs (SECONDARY MATRIX) to an alternate up and down pattern.

C. Turn TIME/INCREMENT switch to the 1 millisecond position.

D. Adjust C20 for best waveshape.

3. RATE TIMING AND RATE GEN. DC BAL.

A. Turn the TIME/INCREMENT to the 1 MILLI/SEC position.

B. Test oscilloscope monitoring pin 3 of V2.

C. Turn red knobs (SECONDARY MATRIX) counterclockwise for minimum width.

Turn OFF rows C, D and E.

D. Adjust RATE TIMING for 1 millisecond/sawtooth.

E. Quickly switch TRIGGER SOURCE from INTERNAL to EXTERNAL and back again several times, while adjusting RATE GEN. DC BAL. for minimum DC shift of sawtooth pattern. Total change in DC level of bottom of sawtooth should be less than 5%.

F. Check time in all ranges of TIME/INCREMENT switch except the 3 fastest positions.

4. FAST RATE TIMING

A. With TIME/INCREMENT switch in the 10 microseconds position adjust C191 (mounted on switch) for correct time.

B. In the 3.3 microsecond/increment position adjust C19J.

C. Remove test scope probe from pin 3 of V2 (to eliminate loading). Monitor main output.

With TIME/INCREMENT switch in the 1 microsecond position, adjust the 1 MICROSECOND TIMING adjust (located on left hand pot. bracket) for correct time.

NOTE: IF ADJUSTMENT CANNOT BE MADE WITHIN 5%, READJUST RATE GEN. DC BAL., THEN REPEAT STEPS 3 AND 4 UNTIL NO MORE ADJUSTMENTS ARE NECESSARY.

TYPE C CALIBRATION PROCEDURE (continued)

1. HORIZ. TRIG. ADJUST

   A. Connect test oscilloscope to pin 9 of V7A. Observe positive-going pulses of approximately 7 volts amplitude. These should occur at the end of each Miller Run-up (if HORIZ. TRIG. control, R36, is misadjusted, output may be wrong amplitude).

      NOTE: PULSE IS NARROW AND FAST. TURN UP INTENSITY ON TEST OSCILLOSCOPE. USE INTERNAL TRIGGER.

   B. Turn TIME/INCREMENT switch to 33 MILLISEC position. Adjust HORIZ. TRIG. (R36) to the mid-point between over-triggering and no-triggering.

      One of the HORIZONTAL front panel neons will be off when not triggering; and all neons will be on, with no smooth flicker of operation, when over-triggering.

   C. Check for proper HORIZONTAL triggering in all ranges of TIME/INCREMENT switch.

TRIGGER MODE

1. TRIGGER MODE OPERATION

   A. There are no adjustments in the LOCKOUT circuits. Check the operation as suggested in the operating instructions under II C.

OUTPUTS

1. SECONDARY MATRIX COMPENSATION

   A. Connect test oscilloscope to MAIN OUTPUT.

   B. Adjust C22 for best waveshape.

2. OUTPUT AMPLITUDE

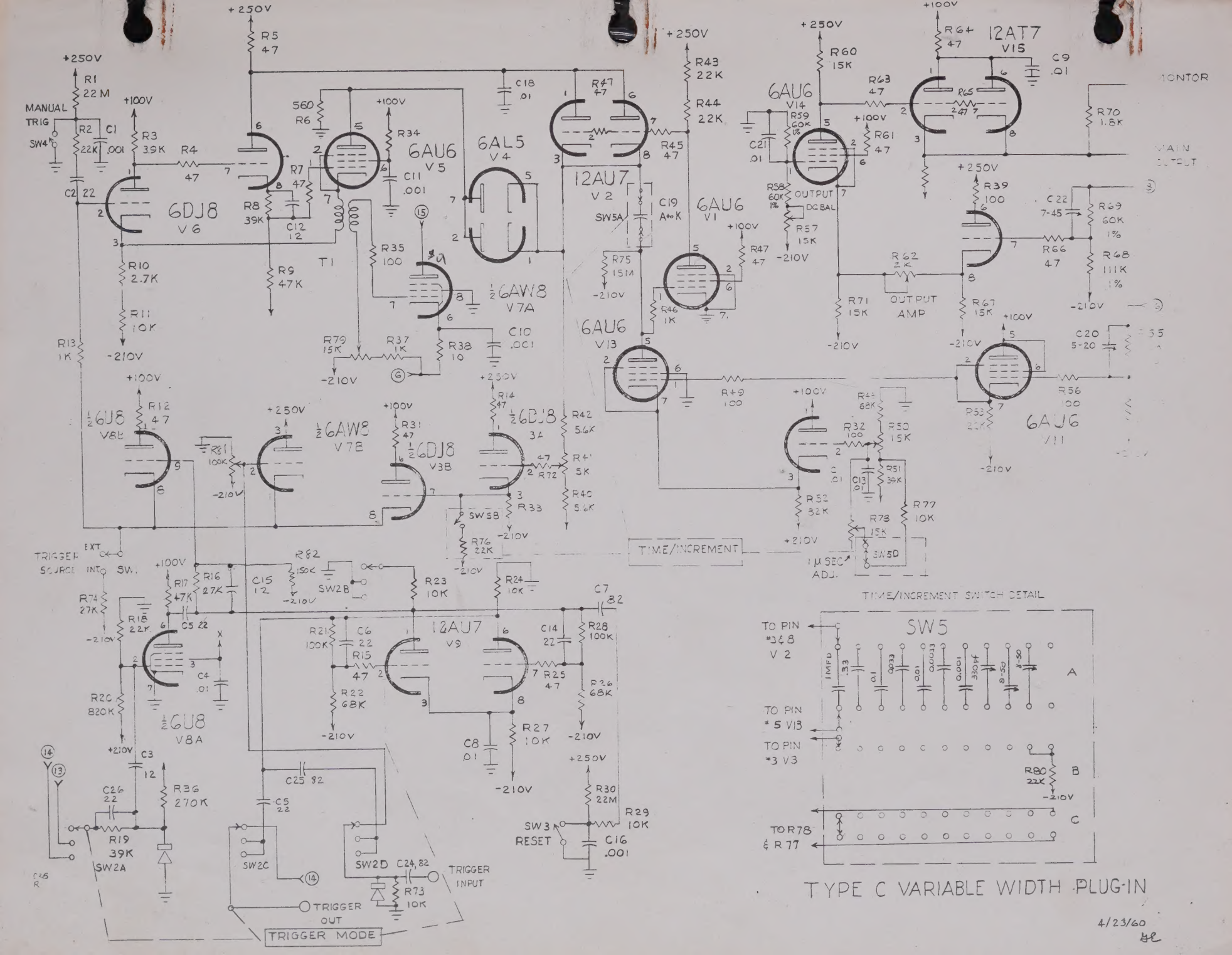
   A. Check OUTPUT for a maximum excursion of 50 volts.

   B. Rotate OUTPUT AMPLITUDE counterclockwise. The output should be reduced by one third.

3. OTHER OUTPUTS

   A. Check TRIGGER OUT for 20 volt amplitude with a clean negative portion (two or more HORIZONTAL rows must be ON).

   B. Check SCALE OF TEN OUT for 40 volts of signal.


+250V
R1 22 M
MANUAL TRIG
SW4
R2 22K
C1 .001
C2 22
+100V
R3 3.9K
R4 47
6DJ8 V6
R5 47
560 R6
R7 47
R8 39K
C12 12
6AU6 V5
R34
C11 .001
T1
R35 100
6AL5 V4
C18 .01
R47 47
12AU7 V2
R43 22K
R44 22K
R45 47
C19 A to K
SW5A
R75 15M
-210V
6AU6 V1
R46 1K
R47 47
R9 47K
R10 2.7K
R11 10K
R13 1K
½6AW8 V7A
R79 15K
R37 1K
R38 10
C10 .001
½6U8 V8B
R12 47
½6AW8 V7B
½6DJ8 V3A
½6DJ8 V3B
R14 47
R31 47
R42 5.6K
R41 5K
R72
R40 5.6K
R81 100K
R33
SW5B
R76 22K
TRIGGER SOURCE
EXT
INT
SW1
R82 150K
SW2B
R16 27K
C15 12
R17 47K
C5 22
R74 27K
R18 22K
R20 820K
½6U8 V8A
C4 .01
C3 12
R36 270K
R19 39K
SW2A
C26 22
C25 82
C5 22
SW2C
SW2D
C24, 82
R73 10K
TRIGGER INPUT
TRIGGER OUT
TRIGGER MODE
R23 10K
R24 10K
C7 .82
12AU7 V9
R21 100K
C6 22
R15 47
R22 68K
R25 47
R26 68K
C14 22
R28 100K
C8 .01
R27 10K
R30 22M
R29 10K
SW3 RESET
C16 .001
R60 15K
6AU6 V14
R59 60K 1%
C21 .01
R58 60K 1%
OUTPUT DC BAL
R57 15K
R61 47
R64 47
12AT7 V15
R63 47
R65 247
C9 .01
R70 1.8K
MONITOR
MAIN OUTPUT
R39 100
C22 7-45
R69 60K 1%
R66 47
R68 111K 1%
R62 2K
OUTPUT AMP
R71 15K
R67 15K
C20 5-20
R55
R56 100
6AU6 V11
R53 22K
R54 68K
R32 100
R50 15K
R51 39K
C13 .01
R52 32K
R77 10K
R78 15K
SW5D
1 μ SEC ADJ.
TIME/INCREMENT
R49 100
TIME/INCREMENT SWITCH DETAIL
SW5
TO PIN #6 V8 V2
TO PIN #5 V13
TO PIN #3 V3
TO R78 & R77
R80 22K
A
B
C
TYPE C VARIABLE WIDTH PLUG-IN
4/23/60